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THE ROLE OF FISH TISSUE MONITORING IN EVALUATING AND MANAGING TOXIC SUBSTANCES: A SUMMARY OF MASSACHUSETTS' PROGRAM

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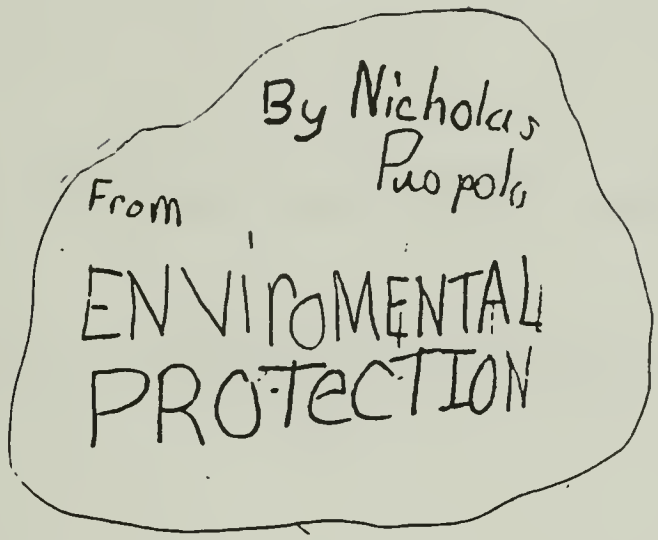

AGE 7

THE ROLE OF FISH TISSUE MONITORING

IN

EVALUATING AND MANAGING TOXIC SUBSTANCES:

A Summary of Massachusetts' Program

R.A. Isaac, R.M. Maietta, A.S. Johnson

This is a slightly expanded version of a paper presented at the Water Environment Federation Annual Conference, New Orleans, LA, September, 1992. Table I and Appenndix 2 have been updated to May, 1994.

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of a paper presented at the Water
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EVALUATING AND MANAGING TOXIC SUBSTANCES

THE ROLE OF FISH TISSUE MONITORING

Russell A. Isaac, Robert J. Maietta, Arthur S. Johnson

"A Wild Fish Should Be Safe to Eat"

M.B. Ettinger and Donald I. Mount
Environ. Sci. Technol., 1:3 p. 203, 1967.

ABSTRACT

With conventional water pollutants from point sources more nearly under control, regulatory agencies have shifted their emphasis to the evaluation of impacts from and the control of toxic substances. As part of this reorientation, the Massachusetts Division of Water Pollution Control initiated an effort to determine contaminant levels in fish tissue and the risks associated with those levels. While both human and ecological risks are of concern, human health risks, for which there is guidance for some compounds, has been the area of initial focus. Among the substances monitored were selected metals (e.g. mercury, See Figure 1), polychlorinated biphenyls (See Figure 2), and occasionally, other chlorinated organic compounds. The objectives of this monitoring were two-fold: to assess potential health impacts to consumers of the fish(non-human as well as human); and to identify waterbodies of concern where controls might be needed. Because of the emphasis on human consumption, edible fish tissue was selected for analysis. This allowed for the application of risk assessment and management strategies irrespective of whether the sources of contamination could be identified or controlled. Fish tissue was selected also because for those constituents that bioaccumulate, it is the most likely medium in which these substances are present in detectable quantities compared to sediments and, especially, water and wastewater.

Over 130 sites comprising 56 waterbodies have been evaluated for some or all of the following: lead, cadmium, chromium, mercury, nickel, copper, zinc and halogenated organic compounds (particularly polychlorinated biphenyls or PCBs although 2,3,7,8 tetrachlorodibenzo-p-dioxin (TCDD) was the focus of one limited study, also). To date, 12 fish consumption advisories have been issued because of contamination by mercury, PCBs, and, in one case each, TCDD and lead. Fish consumption advisories have been issued based on a combination of risk assessment and consideration of any Action Level set by the United States Food and Drug Administration. Advisories issued with regard to the bioaccumulation

of PCBs were usually associated with known or suspected sources of the contaminant. In rivers which were known to be contaminated by PCBs, concentrations as high as 25 ppm wet weight were detected. Mercury followed no apparent pattern with regard to known sources of the contaminant. On many occasions, elevated mercury concentrations were found in predatory fishes from waterbodies which were chosen as "clean water reference" sites. The concentrations encountered were sometimes higher than those found in waters with known mercury contamination. Fillets of large predatory fishes such as chain pickerel, Esox niger, and bass, Micropterus spp. were found to contain mercury concentrations as high as 5.0 ppm wet weight. Given the mercury data obtained thus far, a case can be made to recommend limiting consumption of large predatory fishes from waters which have not been evaluated. In fact, based on the data for PCBs, one could argue for a recommendation to limit consumption of all fishes from waters which have not been evaluated. This would have to be weighed against the health benefits of consuming fish. Continued monitoring is recommended to evaluate specific waterbodies so that definitive recommendations about consumption can be made on a case by case basis and as the best means to judge the impact of those toxic substances which accumulate in fish tissue.

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INTRODUCTION

Toxic water pollutants can affect human health through several pathways including the ingestion of contaminated fish and shellfish. In addition, toxicants can have significant adverse impacts on the health of aquatic life. Since the late 1970s, the U. S. Environmental Protection Agency (USEPA) has encouraged states to monitor and control the discharge of toxins. An important part of such efforts includes the determination of contaminant levels in fish tissue and the risks associated with these levels. Of the many known toxicants, numerical criteria for determining fish edibility currently exist for only a handful of substances. These numerical criteria are the "action levels" developed by the U. S. Food and Drug Administration (FDA) for eight pesticides and for mercury, polychlorinated biphenyls (PCBs), and dioxin (site specific to Great Lakes).

A program currently underway in the Commonwealth of Massachusetts, is monitoring toxic substances in fish tissue. Over 130 sites comprising 56 waterbodies have been evaluated for some or all of the following: lead, cadmium, chromium, mercury, nickel, copper, zinc and halogenated organic compounds (particularly polychlorinated biphenyls, or PCBs, although 2,3,7,8 tetrachlorodibenzo-p-dioxin (TCDD) was the focus of one limited study, also). To date, 12 advisories on consuming fish from various waterbodies have been issued (Table I). This report describes the program's development, implementation, and findings through 1990.

BIRTH OF A PROGRAM

The construction of municipal and industrial water pollution control facilities has

significantly reduced pollutant loadings to Massachusetts rivers and coastal waters.[1] The resulting water quality improvements[2] have led to reestablishment of viable and diverse fish populations in many river systems that had been impaired to the point that they sustained few (e.g. Blackstone River, Nashua River, Millers River, Hoosic River). This enhancement of recreational fishing opportunities coupled with the increasing awareness of toxic pollution led to concerns about the health risks associated with consuming freshwater fishes from some Massachusetts waters. Major sources of toxins in Massachusetts' waters are industrial discharges such as those from electroplating facilities, discharges from municipal wastewater treatment plants that receive significant industrial input, and from non-point sources including urban runoff, in-place sediments and atmospheric deposition.

In 1984, the Massachusetts Department of Environmental Protection's (DEP's) Division of Water Pollution Control (DWPC) and the Division of Fisheries and Wildlife (DFW) established the Toxics in Fish Program. To address the problem in a comprehensive way, a Toxics in Fish Committee was formed, with membership consisting of representatives from several State and Federal agencies. Early discussions revealed that while existing data on fish contamination in the state were sparse, such information would be useful for developing surface water quality standards, NPDES permits, human health risk assessments, and in assessing water quality.

IMPLEMENTATION

Massachusetts implemented the Toxics in Fish Program to accomplish three major objectives:

1. Develop a statewide database of toxic contaminants in freshwater fish.

2. Identify waters where concentrations of toxic chemicals in fish might impact human health.

3. Identify waters where toxic chemicals might impact fish populations and other aquatic life.

To date, fish surveys generally have been restricted to waterbodies where discharge information (e.g. NPDES permit applications) or previous studies have suggested a potential toxic problem. In addition, sampling has been conducted in areas where heavy industrial development or hazardous waste disposal are present. Because of limited resources, human health concerns have received highest priority; for this reason, fish tissue analysis has been restricted to edible fish fillets.

The fish toxics monitoring program was originally carried out using a three phased approach for data collection:

1. Screening Survey. During the initial survey, five to ten fish from at least two

species are collected for analysis. Target species include at least one bottom feeder (e.g. bullhead, Ictalurus sp.) and one resident game fish (e.g. largemouth bass, Micropterus salmoides or pickerel, Esox sp.). One fillet from each fish is pooled and analyzed as a composite with others from the same species while the opposite fillets are archived individually.

2. Confirmatory Analysis. If concentrations found in the screening composites were high relative to existing criteria (where they exist) or to baseline literature values, the archived fillets are analyzed individually to determine a range of concentrations, and a mean is calculated.

3. Follow-up Survey. If contaminant concentrations are at levels of concern in individual fillets, additional fish of several species are collected and individually analyzed.

In most cases, DWPC has begun analyzing both individual fillets and composites during screening surveys. This change was necessitated by variability in both size of fish collected, and in the number of fish per sample. We also have stopped archiving fish because of the need for separate procedures for handling/processing samples for metals and organic compounds.

ADMINISTERING THE PROGRAM

The fish toxics monitoring program is a cooperative effort that involves several state agencies. The DWPC presently employs two aquatic biologists to coordinate surveys, collect field samples, prepare samples, manage data, and write reports. The commitment to these aspects is approximately 1.25 full time equivalents (FTEs). In addition the DFW provides staff and equipment for field sampling when available and necessary. Massachusetts' Lawrence Experiment Station (LES) analyzes the fish and advises the program committee on analytical methods and data interpretation. Finally, both DEP's Office of Research and Standards (ORS) and the Massachusetts Department of Public Health, Bureau of Environmental Health Assessment review data and perform health risk assessments. These agencies also are responsible for deciding to issue consumption advisories and communicating potential risks to the public.

FIELD TECHNIQUES

Uniform protocols, designed to insure accuracy and prevent cross contamination of samples, are followed for fish collection, processing and shipping. Fish are taken with electroshocking gear, gill nets, rod and reel, traps, or trot lines. Lengths and weights of the fish are measured, and they are visually examined for tumors, lesions, or other indications of disease. Scale samples or other hard parts (e.g., pectoral spines) are obtained from each fish for use

in aging.

Fish are filleted on glass cutting boards which are rinsed three times with deionized water before each new sample is prepared. Knives are also rinsed between each sample. Wrapping materials differ depending on the nature of the analysis. For analysis of organic compounds, the fillets are wrapped in aluminum foil. When analyzing for metals, fillets are placed in plastic wrap. The aluminum foil and plastic wrap used for this procedure are household grade products and are used as purchased. All samples are frozen prior to delivery to the laboratory.

CHEMICALS MONITORED AND LABORATORY PROCEDURES

Tests were performed on aliquots of wet tissue that were homogenized in a blender and refluxed for two hours on a steam bath in concentrated HNO_3. While 10 gram samples are the normal aliquot, 2 gram samples were taken for a period of time thus raising the detection limit achievable. The chemicals routinely determined are: mercury (Hg), cadmium (Cd), zinc (Zn), copper (Cu), nickel (Ni), lead (Pb) and polychlorinated biphenyls (PCBs). Methods used at LES for metals analysis include the inductively coupled argon plasma technique for aluminum, cold vapor method using a VGA 76 hydride generator for mercury, and Varian 1475 flame atomic absorption for all remaining metals. PCB analysis was performed on a gas chromatograph equipped with an electron capture detector. The methods used are presented in Table II. TCDD analyses were done by contractors, with the final values used based on results from the Mid-West Center for Mass Spectrometry, the University of Nebraska-Lincoln[5]. Lipid concentrations in the samples were determined in order to normalize the data for halogenated organic contaminants in particular.

RESULTS AND DISCUSSION

The easiest way of examining the entire database is to plot frequency histograms for each contaminant across all species. Plots of selected contaminants are presented in Figures 1-5. Because of varying sizes of sample aliquots, detection limits varied by about a factor of five. As a result, only quantified results were plotted for Cr and Pb. As noted on Figures 2 and 3 respectively, samples that did not have quantifiable concentrations were designated as being in a group with less than the highest detection limit whether or not this was the actual one for a given sample. This was done to avoid inconsistencies in the plots. For PCBs, results were reported as four Arochlors (1242, 1248, 1254 and 1260). A single value for total PCB was calculated by adding these results. When the particular Arochlor was reported as being less than the detection limit, half this value was used in the addition.
The chemicals upon which advisories have been based (mercury, lead and PCBs) are presented in Figures 1, 2 and 5. (TCDD data were not plotted).

Further examination of data may explore the correlation of contaminant concentrations and such variables as water quality measurements (e.g., pH, alkalinity and trophic status of lakes), lipid concentrations in the tissue (for PCBs) and watershed geology (for Hg, in particular). As stated previously, the dominant cause of PCB concentrations that result in advisories appears to be point source discharges. In contrast, mercury concentrations seem primarily to be from nonpoint sources which include atmospheric fallout (from Hg in coal burned for electricity generation?), and chemical erosion, perhaps aggravated by acid precipitation, of naturally occurring mercury in igneous and metamorphic bedrock. On many occasions, elevated mercury concentrations were found in predatory fishes from waterbodies which were chosen as "clean water reference" sites. The concentrations encountered were sometimes higher than those found in waters with known mercury contamination. Fillets of large predatory fishes such as chain pickerel, Esox niger, and bass, Micropterus spp. were found to contain mercury concentrations as high as 5.0 ppm wet weight. Until banned, mercury based paints used for biofouling control on ship hulls also appeared to be the source of Hg in a couple of shellfish beds. Two significant mercury contamination episodes resulted from industrial operations associated with dye manufacture.

For both mercury and PCBs, a number of samples exceeded the FDA action level but in fact it is not clear that applying FDA criteria to sport fish is appropriate. There are several reasons for questioning the relevance of the FDA guidelines in this situation, among which are the assumptions about levels of consumption and the frequency that individuals return to the same area to fish. Thus, any risk assessment for individuals consuming sport fish, to be conservatively protective, assumes that consumers of fish will frequent any given area on a regular basis. Without firm information to the contrary, the FDA exposure assumption of individuals consuming fish at the rate of 6.5 grams/day was used. Both the Office of Research and Standards in the Department of Environmental Protection and the Department Public Health's Bureau of Environmental Health Assessment calculated risks; while different assumptions were used for parts of the analyses, the two groups generally agree on the overall assessment and whether an advisory is warranted. To date (1992), 12 advisories have been issued (Table I). The main criteria have been life time cancer risks in the case of PCBs (and TCDD) and for mercury, the potential neurological impacts on infants, both *in utero* and those being breast fed. For cancer risks, Massachusetts generally has employed an increase of 10^{-6} or less in a lifetime as its goal for individual chemicals and an increase of 10^{-5} or less for mixtures of chemicals. Risks of increased cancer were calculated on an early assemblage of the PCB data by Hutcheson[6] (Figure 6a). His calculations reveal that the FDA tolerance concentration if translated to a daily dose corresponds to a greater than 10^{-3} increased cancer-risk over a seventy year life span (Figure 6b). In fact, a majority of the fresh water fish in this data set have total PCB concentrations associated with an elevated life-time cancer risk (ELCR) of at least 10^{-5} if any of those fish were to be consumed over a lifetime at an average ingestion rate of 6.5 g/d. Note that the ELCR at the detection limit for PCBs is about $1x10^{-5}$. Thus for more than 50% of the samples, the elevated life-time cancer risks exceed Massachusetts' goal of $\leq 10^{-5}$ (i.e., $\leq$ 1 in 100,000) for mixtures of chemicals (Figure 6b). Because PCBs are a group of up to 209 congeners, they are considered a mixture rather than a single chemical.

Sampling for TCDD was the result of concerns that some herbicides used in many ponds to control nuisance aquatic vegetation might have been contaminated with this chemical. After screening the information available on amounts of herbicide used in treating ponds, several waterbodies were selected with the objective of covering the range of loadings.[7,8] Two series of sampling were conducted. Initially, sediment and fish tissue were analyzed. Most values from the first round of testing were below the detection limits, although a few relatively high values were in fact quantified. Because of concerns about both detection limits and quality assurance, archived samples from the one lake with high values were analyzed by a second laboratory. The results confirmed the presence of TCDD. However, again concerns about detection limits and quality assurance led to a second round of sample collection and analysis of the samples by yet a third laboratory. The results from the third laboratory provided the best group of quantified results with 20 of the 22 samples having concentrations above the detection limit. The 20 samples with detectable concentrations had TCDD values ranging from 2 ppt to 15 ppt. Based on this information, an advisory not to consume fish from the pond was issued. The unresolved issue is that the pond in which dioxin was detected was also the one that had received the smallest amount of herbicides over the years of record.

While numerous advisories have been issued, the mechanics of posting and maintaining the physical presence of the notices has been problematic. The follow-up effort to keep the public informed, given the number of advisories, can require substantial resources in toto.

CONCLUSION

Fish tissue data play at least two roles: protection of human health and assessing ecological impacts. To date, Massachusetts' efforts have emphasized human health but have not ignored ecological impacts. The public health aspect has resulted in the issuance of 12 advisories not to consume or to limit consumption of fish from certain waterbodies. In fact, based on the data for PCBs, one could argue for a recommendation to limit consumption of fishes from waters which have not been evaluated. This would have to be weighed against the health benefits of consuming fish. Second, from a monitoring perspective, analyzing fish tissue is a good sentinel for evaluating the presence of those substances which can bioaccumulate or bioconcentrate; for tissue is the medium in which such substances, by definition, occur in the highest concentrations. The extra laboratory preparation effort required to process these samples, is more than offset by the higher concentrations (i.e., more easily detected and quantified) when compared to water samples thus facilitating an assessment. Also, if one monitors water or even sediments, which tend to concentrate some of the same constituents as does fish tissue, one has to estimate the concentrations in tissue; one avoids the uncertainty this presents through measuring the tissue concentrations of contaminants directly. This basic premise is reflected in NOAA's Status and Trends monitoring program which employs mussels as well as some other shellfish to track the presence of selected toxic substances in coastal waters. NOAA does measure concentrations in sediments as well, and mussels have the added advantage of being stationary. Given limited resources, directly

monitoring the compartment of the environment which is the area of most concern is the most efficient and effective approach; for many toxic substances, this compartment is fish tissue.

Table I

SUMMARY OF FISH CONSUMPTION ADVISORIES IN MASSACHUSETTS: NUMBER AND CAUSE(S)

LOCATION	Hg	PCB	DIOXIN	Pb	PAH	PEST	TOTAL
RIVERS	3	3		2[a]	1		12[b]
LAKES	7	1	2		1	1	10[b,c]
COASTAL[d]		3					3
GRAND TOTAL							25[b,c]

[a] Suspect: advisories being reviewed.

[b] Some waterbodies are affected by more than one contaminant, so the advisory is counted only once in total and grand total.

[c] One advisory covers two separate water bodies (Quabbin and Wachusetts Reservoirs) and is being counted as two advisoires.

[d] State wide advisory on lobster taomalley: for women of child bearing age.
Boston Harbor and Quincy Bay: for women of child bearing age and young infants.
New Bedford Harbor.

TABLE II

ANALYTICAL METHODS

Metals - One or More of the following methods [3]

Aluminum:	Method 6010 (ICP)
Mercury:	Method 7471 (Cold Vapor AA)
Copper:	Method 6010 (ICP) Method 7210 (Flame AA) Method 7211 (Graphite Furnace AA)
Cadmium:	Method 6010 (ICP) Method 7130 (Flame AA) Method 7131 (Graphite Furnace AA)
Nickel:	Method 6010 (ICP) Method 7520 (Flame AA)
Lead:	Method 6010 (ICP) Method 7420 (Flame AA) Method 7421 (Graphite Furnace AA)
Zinc:	Method 6010 (ICP) Method 7950 (Flame AA) Method 7951 (Graphite Furnace AA)

Polychlorinated Biphenyls (PCBs)[4]

Method 211.13f:	Extraction of PCBs and Fats from Fish Tissues; Determination of Lipids (Fats) Concentration
Method 211.15:	Florisil Column Cleanup of Fish Extract Prior to PCB Analysis
Method 311:	PCB Analysis by Gas Chromatography with an Electron-Capture Detector

Total Mercury
Fillets of Freshwater Fish

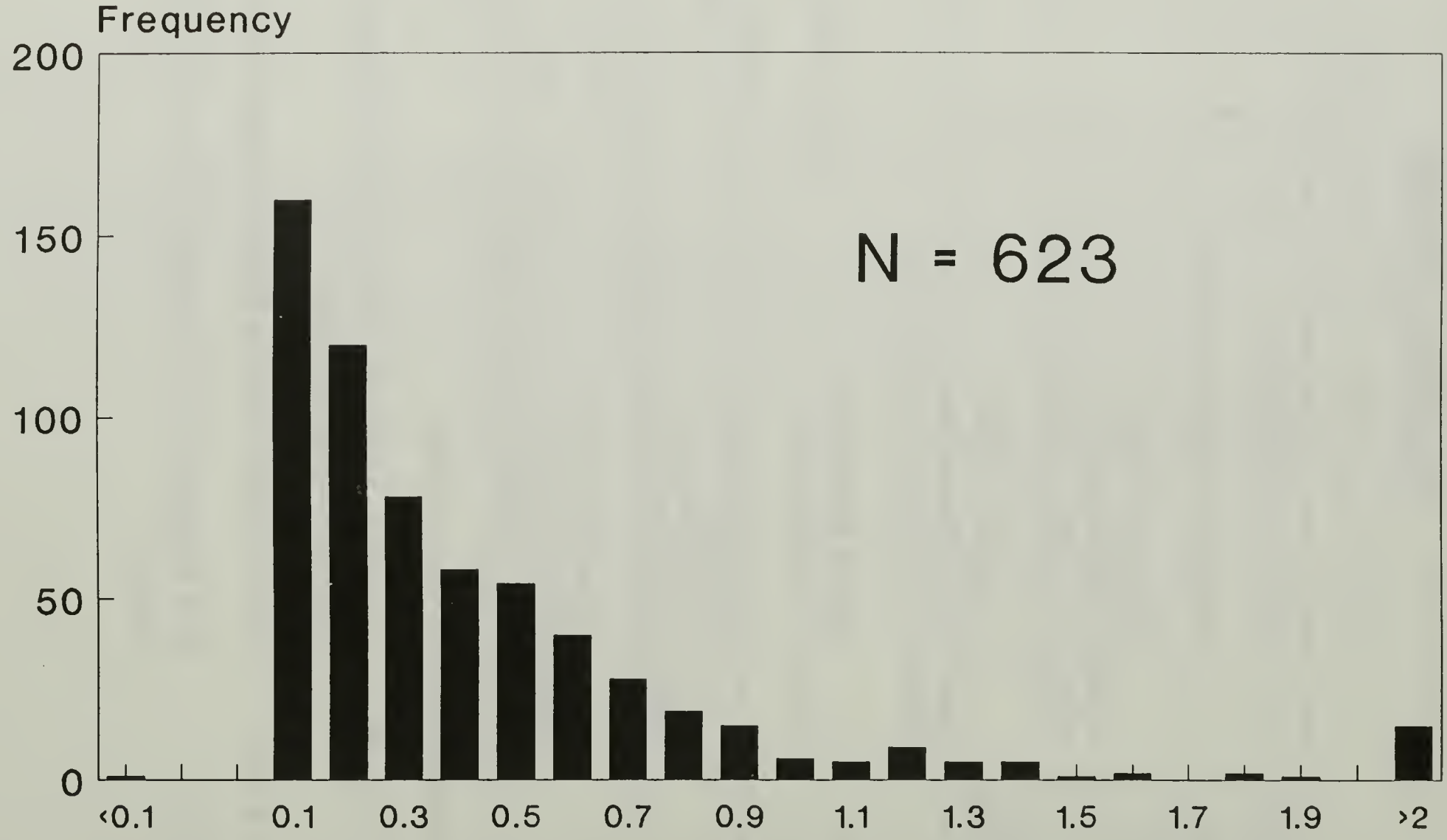

Figure 1

Lead
Fillets of Freshwater Fish

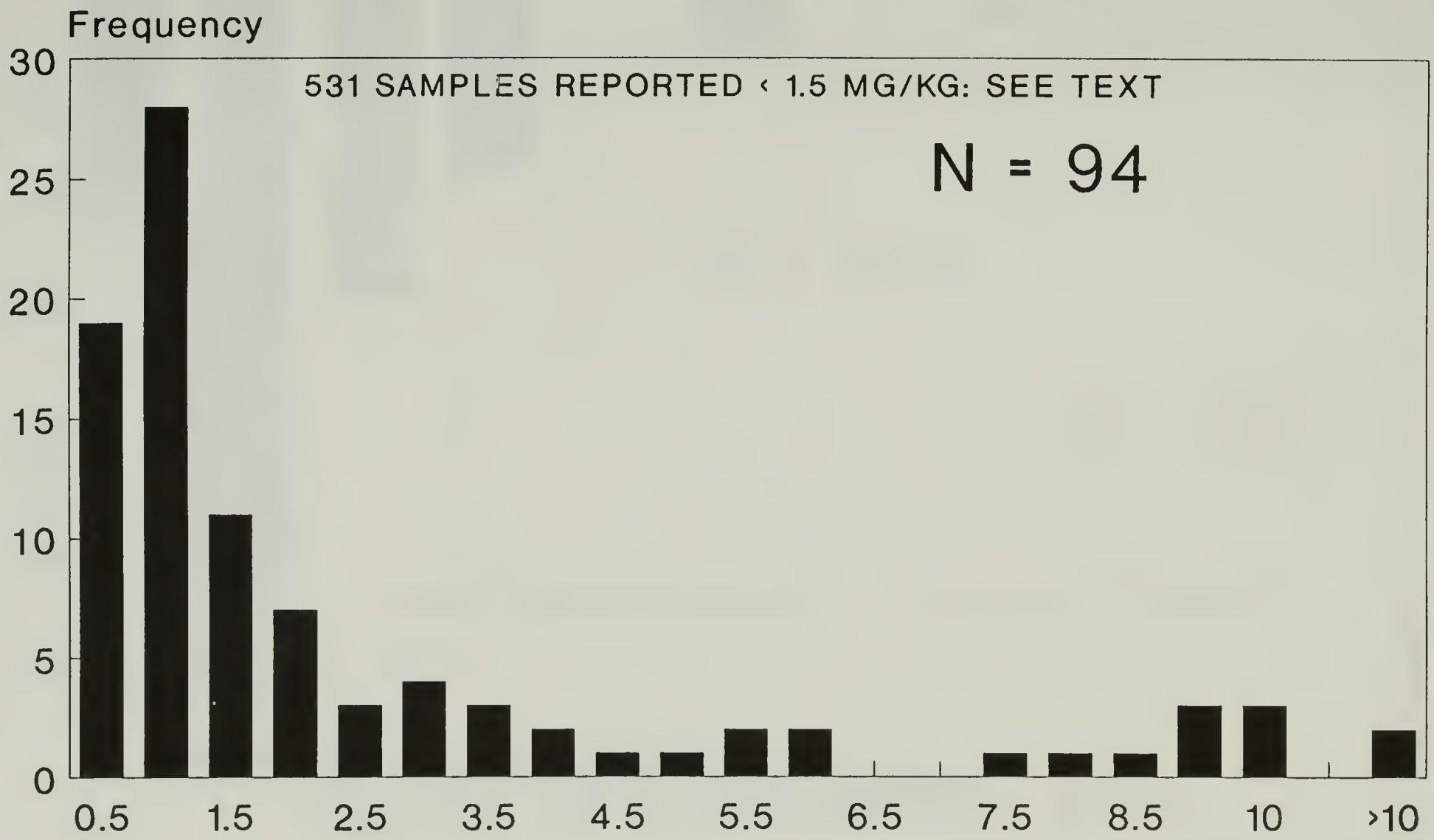

Figure 2

Chromium
Fillets of Freshwater Fish

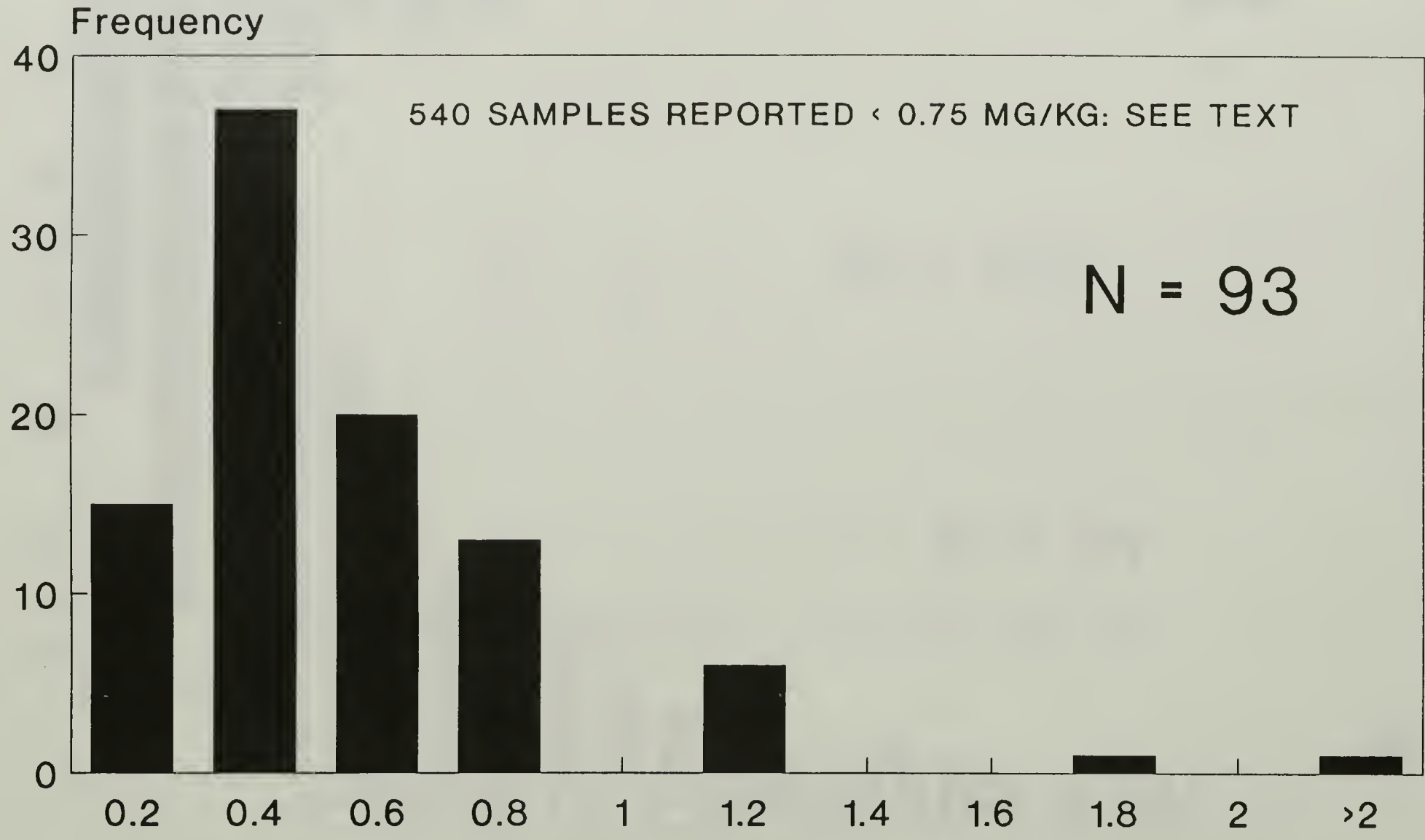

Figure 3

Copper
Fillets of Freshwater Fish

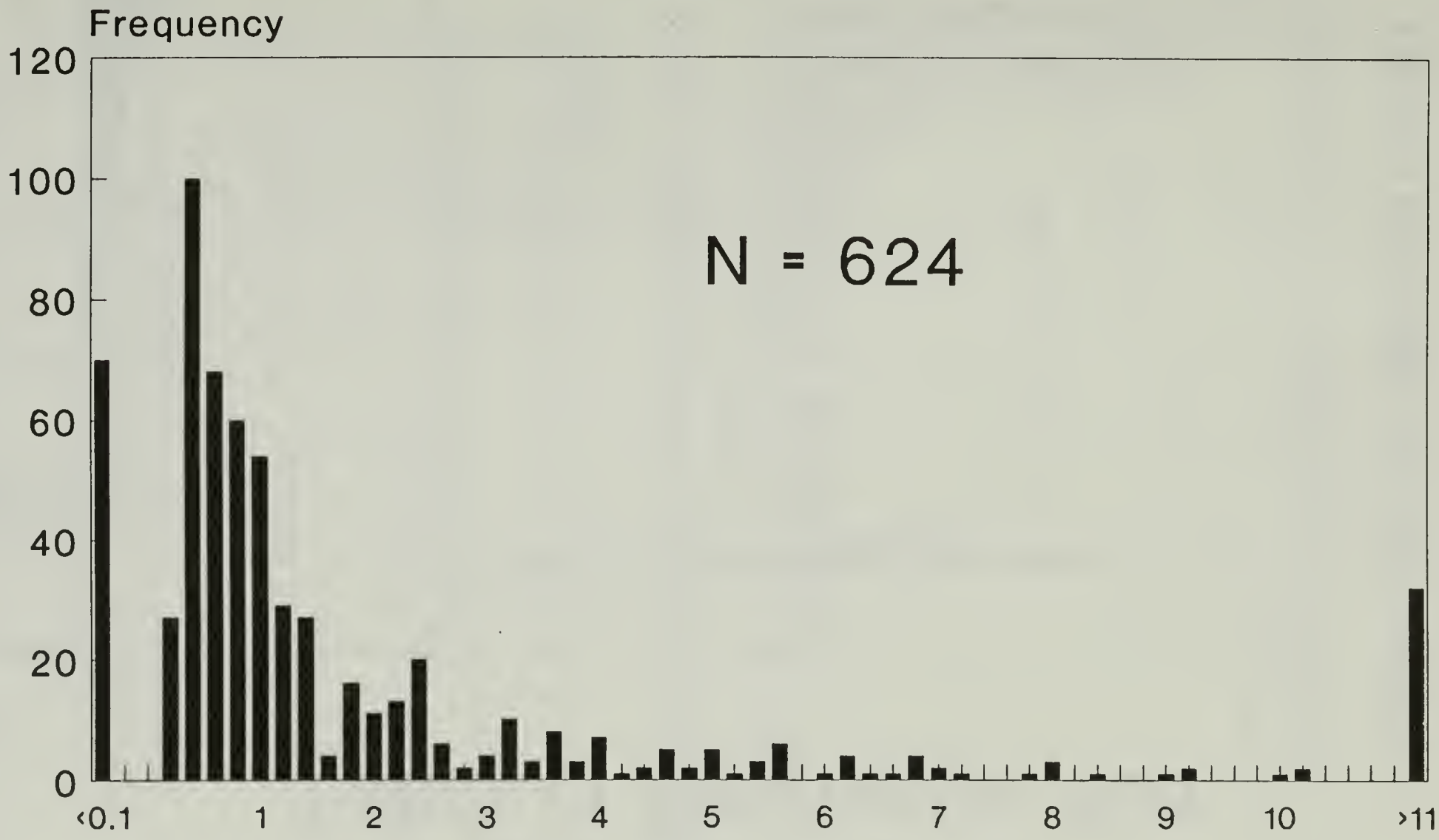

Figure 4

Total PCB's
Fillets of Freshwater Fish

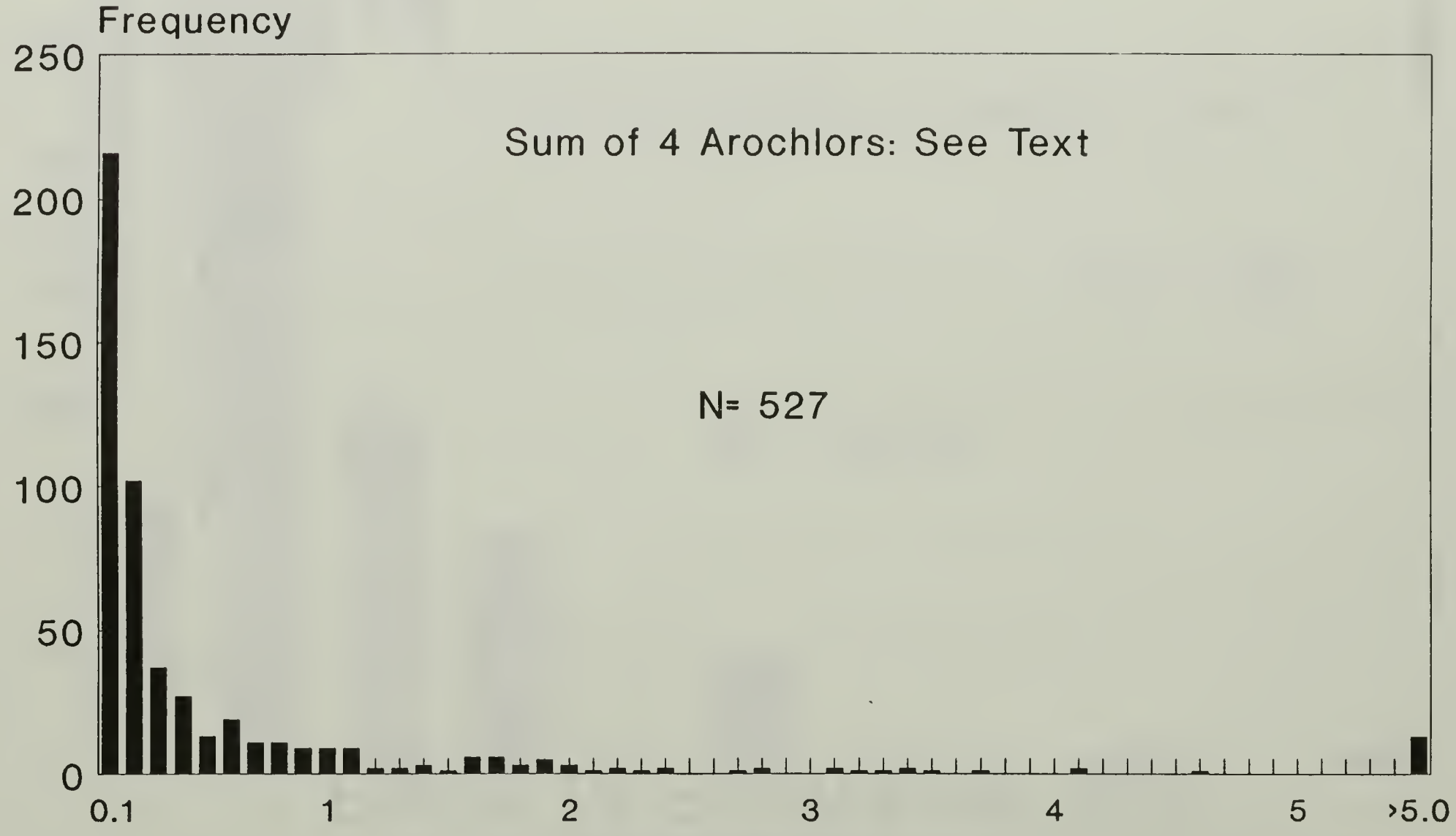

Figure 5

PCB DISTRIB IN MA FISH

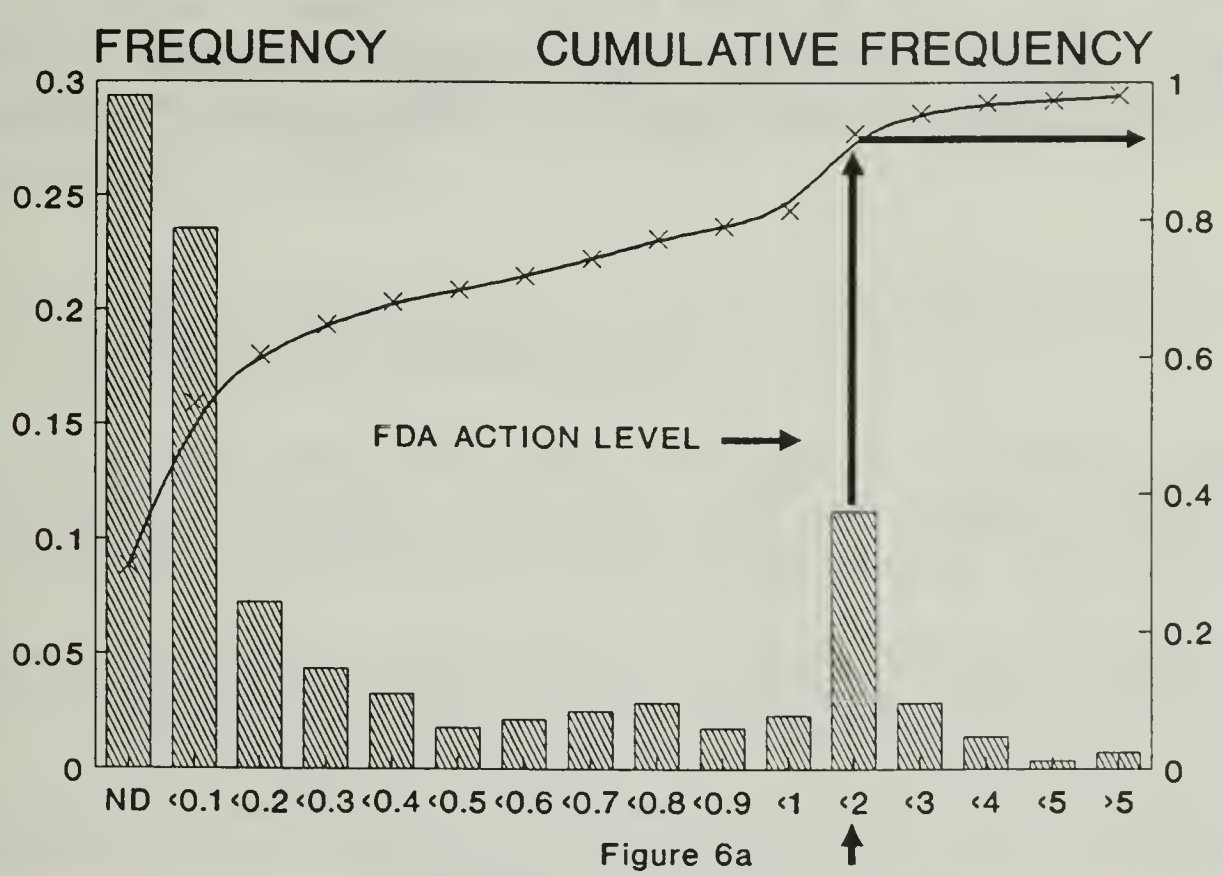

Figure 6a

ELCR VERSUS TISSUE CONCENTRATIONS

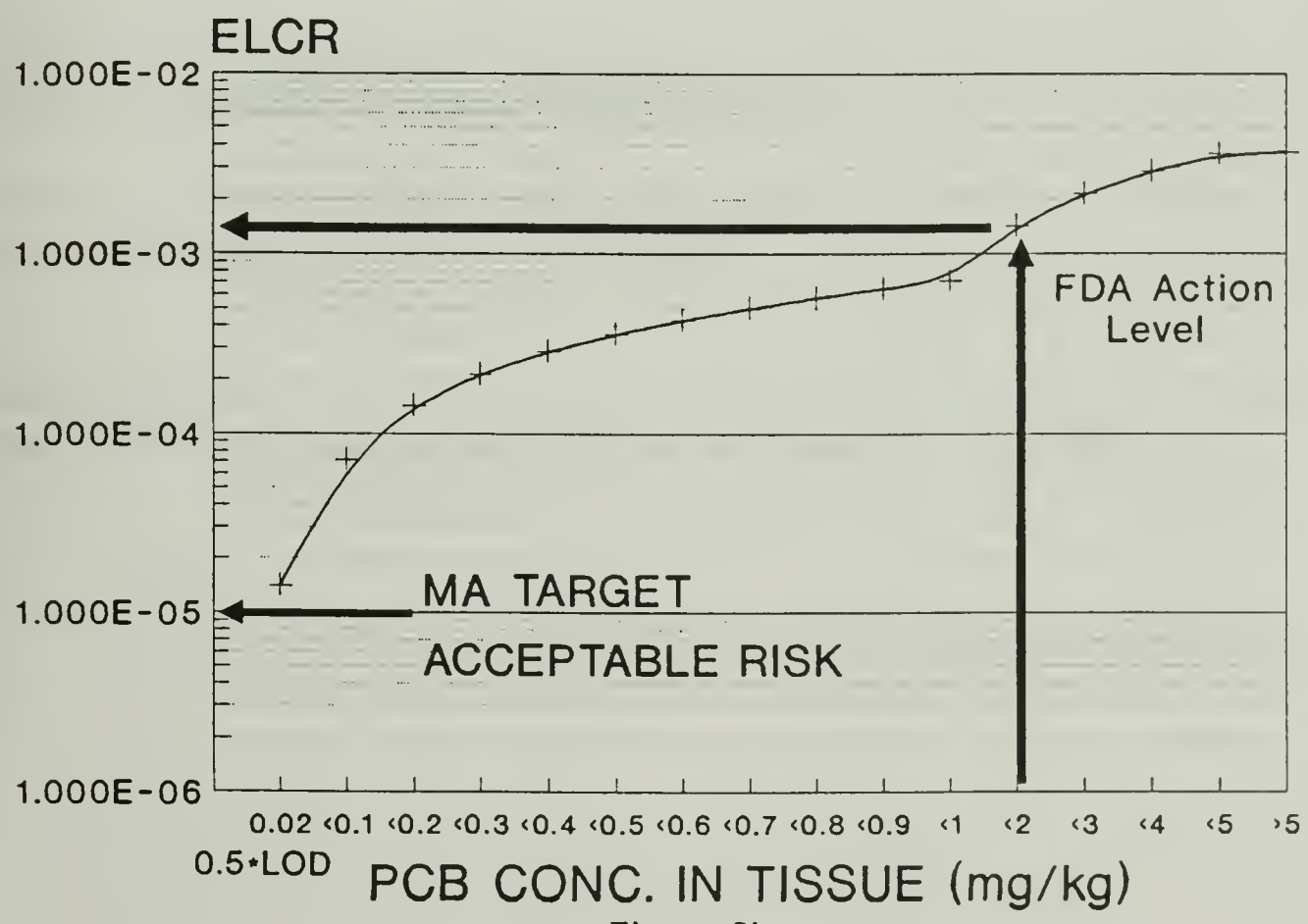

Figure 6b

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APPENDIX 1

WATERBODIES SAMPLED THROUGH 1992

MA DIVISION OF WATER POLLUTION CONTROL
LIST OF FISH TOXICS MONITORING
SURVEYS

WATERBODY	YEAR and CODE	PARAMETERS
Stockbridge Bowl	1983-4	Dioxin
North Pond	1983-4	Dioxin
Lake Winthrop	1983-4	Dioxin
Lake Boon	1983-4	Dioxin
Nonesuch Pond	1983-4	Dioxin
Flint Pond	1983-4	Dioxin
Ten Mile/Sevenmile R.	1984-2	Metals
Lake Winthrop	1984-3	Dioxin
Flints Pond	1985-1	Dioxin, Metals
Blackstone River	1985-2	Metals
Hoosic River	1985-3	PCBs / Organic Scan
Nashua River	1985-5	Metals
Assabet River	1985-6	Metals
Sudbury River	1985-9b	Metals
Cochato River	1985-9c	Dioxin, Metals
Connecticut River*	1985-9d	Metals, PCBs, Pesticides
Hocomonco Pond	1985-9e	PAHs
Millers River	1985-10	PCBs / Organic Scan
South Meadow Pond	86-3	Metals, PCBs / Organic Scan
Sevenmile River	86-6	Metals
Bungay River	86-7	Metals
Sudbury/Concord Rivers	86-8	Metals
Neponset Reservoir	86-9	Metals, PCBs / Organic Scan
Echo Lake	86-10	Metals, PCBs / Organic Scan
Merrimack River	86-11	Metals, PCBs / Organic Scan
Blackstone River**	86-12	Metals
Hoosic River	86-13	Metals, PCBs / Organic Scan
Dimmock Pond	86-16	Metals, PCBs / Organic Scan
Bailey Pond	87-1	Metals
Muddy Pond	87-2	Metals, PCBs / Organic Scan
Millers River	87-5a	Metals, PCBs / Organic Scan
Heard Pond	87-9	Metals, PCBS / Organic Scan
Sudbury River	87-10	Metals, PCBs / Organic Scan
Ten Mile River	87-11	Metals
Blackstone River**	87-12	Metals
Connecticut River	87-14	Metals, PCBs / Organic Scan
Dorothy Pond	87-15	Metals, PCBs / Organic Scan
Shubael Pond	87-16	Metals, PCBs / Organic Scan
Paskamansett River	88-1	Metals, PCB Scan
Copicut River	88-2	Metals, PCB Scan
Indian Lake	88-3	Metals, PCB Scan
Hoosic River	88-6	Metals, PCB Scan

WATERBODY	YEAR and CODE	PARAMETERS
Blackstone River**	88-7	Metals
Connecticut River	88-8	Metals, PCB Scan
Millers/Otter River	88-9	Metals, PCB Scan
Lake Waban	88-10	Metals, PCB Scan
Alewife Brook	88-11	Metals, PCB Scan
Box Pond	88-12	Metals, PCB Scan
Norton Reservoir	88-13a	Metals, PCB Scan
Chartley Pond	88-13b	Metals, PCB Scan
Barrowsville Pond	88-13c	Metals, PCB Scan
Oakland Impoundment	88-13d	Metals, PCB Scan
Deerfield River	88-16	Metals, PCB Scan
Concord River	88-17	Metals, PCB Scan
Ware River	89-1	Metals, PCB Scan
Matfield River	89-2b	Metals, PCB Scan
Wankinco River	89-3	Metals, PCB Scan
Cedar Swamp Pond	89-4	Metals, PCB Scan
Sandy/Walden Pond	89-6	Metals, PCB Scan
Blackstone River**	89-7	Metals
Broad Brook	89-8	Metals, PCB Scan
Green River	89-8	Metals, PCB Scan
Hemlock Brook	89-8	Metals, PCB Scan
Tophet Brook	89-8	Metals, PCB Scan
N.and S.Watuppa Ponds	89-14	Metals, PCB Scan
Lake Denison	90-2	Metals, PCB Scan
Blackstone River**	90-1	Metals, PCB Scan
Mill River	90-3	Metals, PCB Scan
Muddy River	90-4	Metals, PCB Scan
Merrimack River (Q4)	90-5	Mercury
Ten Mile/Sevenmile R.	90-8a	Metals, PCB Scan
Westfield/Little Rivers	90-9	Metals, PCB Scan
Patch Reservoir	91-1	Metals
John's Pond	92-2	Chlorinated Pesticides, PCBs Organophosphorus Pesticides, Chlorinated Herbicides, HPLC Carbamates, Triazine Herbicides, Diquat
Sylvan Lake	92-4	Pesticides, PCBs, Metals, PAHs, Dioxin

* with USFWS (whole fish)
** Riverdale Impoundment

list/glf

APPENDIX 2

FISH CONSUMPTION ADVISORIES ISSUED THROUGH MAY 1994

Public Health Fish Consumption Advisory List For Freshwater Bodies

Water Body	Town(s)	Date	Contaminant(s)	Affected Fish Species	Adv Code
Cedar Swamp Pond	Milford	May 1994	Mercury	All species of fish.	P1, P4
Cochato River See Sylvan Lake					
Concord River	Concord – Billerica	May 1994	Mercury	Largemouth bass	P1, P2, P3
Connecticut River	Northfield to Longmeadow	March 1990–Update April 1988 –Original	Polychlorinated biphenyls (PCBs)	Channel and White Catfish, American eel & Yellow Perch	P2
Copicut River/ Cornell Pond	Dartmouth	May 1994–Update Aug. 1986–Original	PCBs and mercury	 American eel Largemouth bass (Cornell Pond)	P1 P2 P3
Heard's Pond See Sudbury River	Wayland				
Hocomonco Pond	Westborough	April 1986 (EPA Issued)	PAHs	All species of fish.	P5
Hoosic River	No. Adams to Cheshire	May 1994–Update April 1989– Original	PCBs	All species of fish.	P5

Housatonic River	Dalton to Stockbridge	April 1982	PCBs	Fish, Frogs and Turtles	P2
Ice Pond See Sylvan Lake					
Lake Winthrop	Holliston	March 1986	Dioxin	All species of fish.	P5
Mill River	Milford Area	May 1992	PCBs	All species of fish.	P1, P4
Millers River & tributaries below the confluence with the Otter River	Erving to Winchendon	March 1988	PCBs	Brown Trout and American eel	P1, P2, P3
Muddy River	Boston and Brookline	May 1992	PCBs	Brown Bullhead, Common Carp & American eel	P1, P2, P3
Noquochoke Lake	Dartmouth	May 1994	Mercury and PCBs	American eel and Largemouth Bass	P1, P2, P3
Otter River within a half mile from the Millers River	Templeton – Winchendon	March 1990	PCBs	White Sucker & Brown Bullhead	P2
Powder Mill Pond	Barre	May 1994	Mercury	All species of fish.	P1, P4
Quabbin and Wachusetts Reservoirs	New Salem and Boylston Areas	June 1989	Mercury	Large Lake Trout (> 24 inches) Largemouth & smallmouth bass	P1, P2(1)
Sevenmile River (2)	N.Attleboro – Attleboro	June 1986	Lead	All species of fish.	P5

Sudbury River (3)	Ashland to Concord	March 1986	Mercury	All species of fish.	P5
Sylvan Lake	Holbrook, Randolph & Braintree	September 1992	Pesticides and Dioxin	Brown Bullhead, Common Carp and American eel	P1, P2, P3
Ten Mile River (2)	N.Attleboro to Seekonk	June 1986	Lead	All species of fish.	P5
Turner Pond	Dartmouth & New Bedford	May 1994	Mercury	All species of fish.	P1, P4
Walden Pond	Concord	May 1994	Mercury	Largemouth & smallmouth bass	P1, P2

Public Health Advisory Codes:

P1 = Children under 12, pregnant women and nursing mothers should not eat fish from this water body.
P2 = The general public should not consume any affected fish species from this water body.
P3 = The general public should limit consumption of all non-affected fish species from this water body to 2 meals/month.
P4 = The general public should limit consumption of all fish from this water body to 2 meals/month.
P5 = The general public should not consume any fish from this water body.

Legend: (1) The general public may eat one (5 oz.) meal/week of other species & unlimited amounts of lake trout (< 24 in.) and salmon.
(2) The advisory is being reconsidered due to laboratory reevaluation.
(3) Sudbury River Fish Consumption Advisory pertains to the extent from Ashland to the confluence with Assabet and Concord Rivers and includes the Stern and Brackett Reservoirs in Framingham.